Abstract

Semiconductors such as $CuInGaSe_2$ and CdTe have been investigated as absorber layer materials for thin film solar cells since their band gap matches with the solar spectrum. Films as thin as 2μm are sufficient for the absorption of the visible part of solar radiation, because they are characterized by a high absorption coefficient. However, the scarcity and high costs of Indium, Gallium and Tellurium have led to concerns on the sustainability of these technologies. The semiconductor Cu_2ZnSnS_4 (Copper Zinc Tin Sulphide) consisting of abundantly available elements promises to be an excellent photovoltaic absorber material. The present study is focused on the growth and characterization of CZTS/ZnS thin film heterostructure suitable for PV applications.

Ultrasonic Spray Pyrolysis (USP), a variation of Spray Pyrolysis is a thin film deposition technique where the solution to be sprayed is atomized by ultrasonic frequencies. The details of the USP experimental set up and the deposition principle are presented in the thesis. The active layers of the solar cell, *viz.* the CZTS absorber layer and ZnS emitter layer were grown by this technique. The metal top contact was deposited using e-beam evaporation.

The effects of copper concentration and sodium diffusion on the Cu_2ZnSnS_4 film properties were investigated. The films have shown preferred orientation along (112) direction confirming kesterite structure. The optical studies revealed that a reduction of copper in the films will bring the band gap energy to 1.5eV, which will match with the solar spectrum. Sodium diffusion in the CZTS films is found to passivate the grain boundaries and enhance the electrical conductivity. These properties render CZTS films as good photovoltaic absorber layers.

ZnS has a high band gap and is non toxic unlike CdS. The influences of variation in substrate temperature and spray duration on the ZnS film properties were examined. The optical studies conducted on ZnS films revealed that they are highly transparent in the visible region of the solar spectrum. The films were found to possess a band gap of 3.5 eV. These properties make them potential candidates as solar cell emitter layers.

The CZTS/ZnS heterojunction solar cell was fabricated and subjected to electrical characterization in dark and illuminated conditions. A conversion efficiency of 1.16% was achieved for the device.